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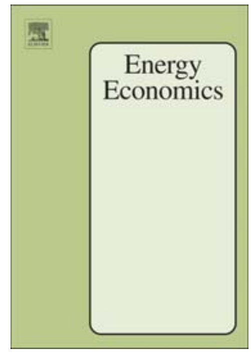

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Free cash flows and overinvestment: Further evidence from Chinese energy firms

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Abstract

In the recent years, Chinese energy firms have accumulated significant free cash flows due to higher energy prices and government subsidies and also have invested heavily. An important empirical question is whether the Chinese energy firms tend to misallocate resources due to growing free cash flows. In this paper, we test whether they make some sub-optimal investment decisions following the well-established free cash flow problem in the finance literature, originally identified by Jensen (1986) for the US oil sector. Using a dynamic panel model for the period 2001-2012 for the Chinese energy-related public listed firms, we find evidence supporting the free cash flow hypothesis, suggesting over-investment problems in the Chinese energy sector. In addition, we observe that firm size and corporate governance structure are important determinants of the Chinese energy firms' investment decisions.

JEL: G31 G32 Q4
Keyword: Free cash flow, Energy firms, Fundamental Q, Dynamic Panel Data Model, Panel VAR

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1. Introduction

Higher energy prices in the new century, especially in oil prices, have created significant opportunities and challenges in the world economy, triggering substantial research on its consequences in the literature.[1] The Brent oil price, which was $23.64

[1] Higher energy prices have affected many key macroeconomic variables in China and other emerging markets as

per barrel in January 2000, rose to $112.51 in January 2012. Such radical changes in crude oil prices over time have generated significant free cash flows in the oil industry, which, among others, are related to financial stress (Nazlioglu, Soytas and Gupta, 2015) and risk-spillovers from energy companies to the other commodities (Soytas and Oran, 2011; Gormus, Soytas and Diltz, 2014).

The Chinese energy sector has also been affected by changes in oil prices. Figure 1 provides information about the impact of the growing oil prices on the cash flows of China's energy related firms compares them with the other firms.[2] The left panel of Figure 1 shows the cash flows in levels. On average, the cash flow of the energy firms is larger than that of the firms in other industries by as much as six times. The difference has been more significant after the 2008 financial crisis when oil prices rebounded quickly after a significant drop during the crisis. The right panel of Figure 1 exhibits the percentage of cash flows for energy firms and also the share of such firms in overall firms (excluding financial firms) listed on the Shanghai and Shenzhen stock exchanges. The percentage of cash flows in energy firms relative to all firms is well above 15% and reached around 25% in the period 2009–2012. In addition, the Chinese energy firms have been actively involved in exploration and development (E&D) activities and spent heavily on investments around the world. According to the Heritage Foundation, there has been around $144 billion direct investment between 2005 and 2011 (Tan, 2013) from China to the rest of the world in the energy/resource sector, which accounts for about 47% of all outward direct investment of China.

The general picture observed in the Chinese energy sector in the recent years is similar to what Jensen (1986) illustrated about the US oil industry during the 1980s. As Jensen (1986, p. 326) stated: "the 1984 cash flows of the ten largest oil companies were $48.5 billion, 28 percent of the total cash flows of the top 200 firms in Dun's Business Month survey." The managers of these firms did not pay dividends to the shareholders, but they instead spent heavily on E&D and diversification programs outside of the oil industry. McConnell and Muscarella (1986) find that these expenditures reduced those firms' stock prices and the recovery rate in these investments ranged from 60 to 90 percent. Similar concerns have been raised in the literature about the Chinese firms. For example, Wei et al. (2004), point out that the Chinese firms are reluctant to pay dividends. Hofman and Kuijs (2006) suggest that the high savings of domestic enterprises play an important role in China's fast economic growth.[3] Such high savings, in part, are mainly due to 'windfall' profits in the state owned sector, especially in the energy and resource related industries. Low

well, causing wealth effects due to changes in share prices (Balcilar, Gupta, and Miller, 2015; Lin, Fang and Cheng, 2014; Nikkinen, Saleem, Martikainen and Omran, 2014; Sukcharoen, Zohrabyan, Leatham and Wu, 2014), exchange rates (Sari, Hammoudeh and Soytas, 2010; Basher, Haug and Sadorsky, 2012; Turhan, Hacihasanoglu and Soytas, 2015) and the inflation rate (Tang, Wang and Wang, 2014; Zhao, Zhang, Wang and Xu, 2015).

[2] The energy firms in our study include the traditional energy industry (i.e. electricity, oil, coal and gas) and the non-traditional sector plus energy related firms (i.e. new energy firms and machinery manufacturing firms). More details on the selection of energy firms are discussed in the data section.

[3] For other studies linking energy issues to economic growth, see, among others, Guan, Zhou and Zhang, (2015), Jalil and Feridun (2014), and Yuan, Xu and Zhang, (2015).

dividend payments by firms over time may suggest agency problems.[4]

An important question we address in this paper is therefore whether the investments by the Chinese energy related firms increase the value these firms. Do managers of these firms have agency problems, as Jensen (1986) suggested, and hence act at the expense of their shareholders? Finding out an answer to this question has important policy implications. The empirical methodology of testing this question is well established in the main stream finance literature. Jensen (1986) proposed the free cash flow (FCF) hypothesis following the US case. He defines the FCF as the excess cash flow over what is required to fund all projects with a net positive present value (NPV). According to the FCF hypothesis, firms with free cash flows tend to face higher agency costs due to conflict of interest between shareholders and managers. Firm managers have strong incentives to invest rather than distribute the FCF as dividends despite poor investment opportunities (represented by a negative NPV). Since, in this case, the return on investment is lower than the cost of capital, investments with negative NPVs hurt the shareholders, causing the FCF problem. Following this logic, Lang and Litzenerger (1989) introduce an interaction term of cash flow and a proxy of future investment opportunities to test for the FCF problem. Cash flows can increase investment, but observing higher investment volumes during times of poor future opportunities indicates agency problem.

The key issue is how to specify future investment opportunities. Lang and Litzenberger (1989) initially suggest Tobin's Q, the ratio of the market value of the firm's assets to their replacement cost, to distinguish good investment opportunities from bad ones. However, Gilchrist and Himmelberg (1995) criticize that the Tobin's Q has low explanatory power and is an insufficient measure of investment opportunities. We therefore use the fundamental Q proposed by Gilchrist and Himmelberg (1995) in our empirical analysis. Furthermore, the FCF problem may be sensitive to a set of variables such as the corporate governance (i.e. ownership structure), size, and financial constraints. We also control for these factors in our empirical analysis when testing the FCF hypothesis. The results show that these factors indeed play an important role in testing in the FCF hypothesis for Chinese firms.

The rest of the paper is organized as follows. Section 2 briefly reviews the growing literature on testing the FCF hypothesis and related studies on the energy sector. Section 3 explains the method of estimating the fundamental Q and testing the FCF hypothesis. Section 4 describes the data while Section 5 reports the empirical results. The last section concludes the paper.

2. Literature review

[4] However, Bayoumi et al. (2010) challenge this view. Based on a firm-level dataset, they report no significant difference between the corporate saving rate in China and the rest of the world.

Since Jensen's (1988) study on the free cash flow problem, there have been numerous studies in the finance literature trying to test this hypothesis. Initial studies including Lang and Litzenberger (1989) and Lang et al. (1991) use Tobin's Q to measure investment opportunities. Vogt (1994) suggests that both the free cash flow and the pecking order hypotheses are potential explanations for the investment/cash flow relationship. Perfect (1995) finds evidence for the FCF using the current measure of Q, but not for that of the long-run Q (average Q). Since then, many followers have studied this issue using data from different countries (e.g., Pawlina and Renneboog, 2005 and Wei and Zhang, 2008).

It is important to identify good investment opportunities when testing the FCF problems. The good opportunities are often refer to projects with a positive NPV. It is often said that a higher Tobin's Q indicates good opportunities and investment is supposed to be more productive, thus increasing the firm's market value. For example, Lang and Litzenberger (1989) take Tobin Q's being unity as the threshold to test whether a firm overinvests (where Q is less than one), which is consistent with the FCF theory. Their empirical results are generally supportive of the FCF hypothesis. Furthermore, Lang et al. (1991) also use Tobin's Q as the proxy of investment opportunities and tested the FCF hypothesis in the case of tender offers. Their results are also supportive of the FCF hypothesis.

Despite the popularity of Tobin's Q, many researchers have found poor explanatory power in their empirical studies (see, among others, Hubbard and Kashyap, 1992). The feasibility of using Tobin's Q is criticized by Gilchrist and Himmelberg (1995), however. They point out that the low explanatory power of Tobin Q and implausibly high estimates of the adjustment cost parameters reported in previous studies make Tobin Q insufficient to control for investment opportunities. A new measure is then introduced by Gilchrist and Himmelberg (1995) to estimate Q from firm level fundamentals, and is referred to it as the 'fundamental' Q. This alternative measure of Q not only takes the current proxy for investment into account, but also employs a forecasting procedure to be more explicitly allowing for future investment opportunities.

Although the issue of FCF problem was initially arisen from the oil industry and energy-related firms, empirical studies on this particular industry are relatively less developed. Early studies such as Griffin (1988) extends the general finance literature to oil industry firms and finds supporting evidence of FCF and proves that agency problems exist in the US energy industry. Lamont (1997) looks at the firms' reactions to oil price shocks and finds that oil firms' reactions are consistent with the agency cost hypothesis as they fail to react optimally to lower oil prices. The common features of these existing studies on developed countries are that they use Tobin's Q and most of them support the existence of agency problems in the energy industry.

Entering the new century, China has facing ever-increasing pressure of energy demand. To secure supply of energy for maintaining a sustainable and stable economic growth, China has invested heavily both domestically and across the world. Tan (2013) surveys the status of China's overseas investment in the energy and resource sectors. The general message is that investment from the energy and resource sector account for a significant portion of total investment from China to the rest of the world, in terms of both scale and speed of growth.[5] Given the size and importance of this investment, it is therefore not only crucial for private investors, but also for the government to evaluate the efficiency of energy investment. Hence, studying the investment behavior of Chinese energy firms is important to understand the fundamental incentives of the managers of these firms. Although there are some empirical studies on the FCF problems in China (e.g., Chen et al., 2001, Huang et al., 2011), there are not many studies focusing on China's energy firms. Recently, renewable energy sector in China has experienced a remarkable speed of growth, which essentially triggers some heated debate about whether these investments have been rational. For example, Zhang et al. (2015) provide empirical evidence of overinvestment in the renewable energy firms. Their methodology is essentially the same as that used in the main stream finance literature. There is clearly a gap in the existing literature that combines the detailed exploration of FCF problem in the energy related firms in China with an appropriate measure of future investment opportunities.

Following recent studies, this paper also incorporates several standard measures of corporate governance factor into the test of FCF problem. For example, Gugler et al. (2013) study the determinants of investment in the electricity market and find ownership unbundling, price, and regulation affect investment decisions. Chen et al. (2013), among others, show a significant role of corporate governance factor in firms' investment decision, which is especially relevant for the firms in China.

3. Methodology

The section briefly explains the methodology used in the empirical parts. In particular, we first discuss how to estimate the fundamental Q, which replaces Tobin's Q, and then describe a dynamic investment model used to test for the FCF hypothesis.

3.1 Estimating Fundamental Q model

Gilchrist and Himmelberg (1995) construct an alternative proxy for measuring future investment opportunities, namely, the 'fundamental' Q, using a panel VAR approach. Let $E[Q_{it}|\Omega_{it}]$ represents the shadow price of capital or marginal Q, where Ω_{it} is the information set at time t. Marginal Q equals to the discounted stream of future marginal profitability of capital, which is given by $\sum_{s=0}^{\infty} \lambda^s E[\pi_{it+s}|\Omega_{it}]$, where λ is the discount factor and π_{it+s} represents profit of firm i at time t+s.

[5] For a recent assessment of China's energy policy and developments, see Li and Du (2013), Kalyuzhnova and Lee (2014), Wang, Li and Wu (2014), Xu, Fan and Yu (2014), and Lin and Li (2015).

Considering a vector X containing observed fundamentals (a subset of the information set), a first order panel VAR model can be written as:

$$X_{it} = AX_{i,t-1} + f_i + d_t + u_{it} \qquad (1)$$

Equation 1 allows us to control for firm-specific effects through f_i and a vector of common aggregate shocks over time to all firms d_t . u_{it} represents panel residuals and are assumed to be orthogonal to the lags of X_{it} . Forward substitute of the model in Equation 1 and applying the law of iterated expectations produces the following expression:

$$E\left[X_{i,t+S}|\Omega_{it}\right] = A^s X_{it} + \Gamma_1 f_i + \Gamma_2 d_t \qquad (2)$$

where Γs are complicated functions of the parameter f, A and d_t. Suppose π is the j^{th} element of X_{it} , then we can write $\pi_{it} = C' X_{it}$, where C is a vector of zeros with one in the j^{th} row and it is conformable to X_{it}. The 'fundamental' Q can then be written as:

$$FQ_{it} = E[Q_{it}|\Omega_{it}] = \sum_{s=0}^{\infty} \lambda^s E\left[C' X_{i,t+s}|\Omega_{it}\right] = \sum_{s=0}^{\infty} \lambda^s E[C' A^s X_{it}|X_{it}]$$
$$= C' \sum_{s=0}^{\infty} (\lambda A)^s X_{it} = C^{'}(I - \lambda\widehat{A})^{-1} X_{it} \qquad (3)$$

where I is the identity matrix and $\widehat{A}$ is estimated in Equation (3).

3.2 The investment model

In order to test the FCF hypothesis, we follow the initial work by Fazzaki et al. (1988) and write our model as follows:

$$(I/K)_{it} = \beta_0 + \beta_1 Q_{it} + \beta_2 (CF/K)_{it} + \omega_i + \tau_t + \varepsilon_{it} \qquad (4)$$

where I/K stands for investment divided by the beginning-of-period capital stock and CF/K stands for the cash flow scaled by the same capital stock. Q is the proxy for investment opportunities as defined above. This model also allows for the firm-specific and time-specific fixed effects through ω_i and τ_t, respectively.

Lang et al. (1991) propose to use Tobin's Q as a proxy for investment opportunities and set unit value as a threshold to test for the FCF hypothesis. For firms with high Tobin's Q ($TQ_i > 1$), they are considered as having good investment opportunities. After adding more control variables denoted by Z, they set up the following empirical model:

$$(\mathrm{I/K})_{\mathrm{it}} = \beta_0 + \beta_1 \mathrm{TQ}_{\mathrm{it}} + \beta_2 (\mathrm{CF/K})_{\mathrm{it}} + \beta_3 \left[\left(\frac{\mathrm{CF}}{\mathrm{K}}\right)_{\mathrm{it}} \times (\mathrm{TQ}_{\mathrm{it}} < 1)\right] + \delta \mathrm{Z}_{\mathrm{it}} + \pi_{\mathrm{i}} + \tau_{\mathrm{t}} + \varepsilon_{\mathrm{it}} \qquad (5)$$

where I(·) is a function that equals unit when the statement in the brackets is true and zero otherwise. $(\mathrm{TQ}_{\mathrm{it}} < 1)$ is a dummy variable equals 1 if Tobin's Q less than 1, which is used to represent poor investment opportunities (Lang et al., 1991).The key indicator here is β_3. If it is positive, it means that firms with lower investment opportunities invest their cash flows supporting the FCF hypothesis.

In our analysis, we follow the literature and include $(\mathrm{I/K})_{t-1}$, $(\mathrm{I/K})^2_{\mathrm{i,t-1}}$ and $(\mathrm{D/K})^2_{\mathrm{i,t-1}}$ in all our estimated regressions to control for non-modeled firm characteristics, adjustment cost and the probability of bankruptcy. We also replace the Tobin's Q with the fundamental Q to represent future investment opportunities. Of course, the threshold value is not unity in this case.[6] Since the models include lagged dependent variables, we employ the dynamic panel data model (DPD) estimation technique developed by Arellano and Bond (1991), Arellano and Bover (1995) and Blundell and Bond (1998) and estimated through the system GMM method.

4. Data description

Energy related firms listed in the Chinese stock market cover electricity, coal, oil and gas, the new energy sector, and other related industries. The choice of these firms is based on the Global Industrial Classification Standard (GICS) four digit code (1010). In order to further confirm the choice of our sample companies and avoid missing any related information, we also utilize a couple of classifications from two main Chinese financial information websites.[7] After adding this information and upon further scrutiny, our sample includes 169 energy-related firms. Broadstock et al. (2012) also use a similar methodology in selecting number of firms in their sample.

The information about the financial statements and shareholding structures of the firms are collected from the RESSET database. Our sample is annual and covers the period from 2001 to 2012. Given that a balanced panel is needed for estimating the fundamental Q, we exclude data prior to 2001 as doing so would significantly reduce the number of firms in the sample. After controlling for missing data and outliers (winsorizing the top and bottom 1% for cash flow), the estimated balanced panel includes 99 firms.

Considering that the calculation of fundamental Q first requires us to run a panel VAR model and the estimated model is used for forecasting, we adopt a rolling windows

[6] Please refer to section 5 for more details how we define good investment opportunities using fundamental Q.
[7] www.jrj.com.cn and Sina Finance (http://finance.sina.com.cn)

method to compute the fundamental Q. To do so, we need to drop the first four years for the second step regression analysis (as the panel VAR model requires a one-year lag). In general, the total number of observations in our sample set is 1188 and the effective sample size for estimating the investment model are 792 (from 2005 to 2012).

The model variables and their sample means are defined in Table 1. We observe that the full sample mean (the sample includes all available data, including those used in the panel VAR model) is very close to the effective sample mean (the sample used in the investment model estimation) in Table 1, suggesting that the results are robust to the choice of the sample period.

Following Bond and Meghir (1994), the cash flow variable is calculated by adding up operating profits before tax, interest and dividend and fixed asset depreciation. Debt is the total liabilities, which include both short-term and long-term loans. These two variables, as well as investment, sales, profit are scaled by the beginning period book value of fixed assets (adjusted for depreciation).

The size and ownership structure variables are shown to affect firm performance and firms' financial constraints, which, in turn, affect investment decisions. For example, Chow and Fung (2000) show that the size variable matters in Chinese manufacturing firms. Xu and Wang (1999), Qi et al. (2000), Sun et al. (2002), and Poncet et al. (2010) report that state ownership affects firm performance and financial constraints of the firms. In order to further investigate the influence of corporate ownership on investment decisions, the full sample is divided according to the size of the firms as follows: State ownership shares, institutional shares, and management shares.

The average values of these variables for the sub-samples, which are reported in Table 2, show some noticeable differences. When we consider the key variables such as investment and different measures of Q, we observe that small energy firms tend to have lower level of investment but better investment opportunities (both in terms of TQ and FQ). Low state share firms tend to investment more and have better investment opportunities. The mean values of Tobin's Q and Fundamental Q are not always consistent. For example, firms with high management holdings tend to have significantly higher fundamental Q but this does not hold in case of Tobin's Q. In general, the simple descriptive statistics provide some interesting preliminary information to further proceed to the empirical analysis.

The global financial crisis (GFC) in 2008 is expected to have a significant impact on firm investment and output around the world. Inevitably, the firms in China were also affected (see, among others, Bo, Driver and Lin, 2014; Wan and Jin, 2014). Figure 1 shows the cash flow differences before and after the GFC for energy related firms in China. It is therefore important to control for the potential influence of the crisis on investment decisions in the empirical analysis. To do so, a GFC dummy variable is constructed, which equals unity in 2008 and 2009 and zero otherwise.

5. Empirical results

In this section we report the empirical results based on the investment model and fundamental Q summarized in Section 3. Both the full- and sub-sample results based on firm size and various ownership structure factors are estimated. We first discuss the baseline investment model results and then, following Lang and Litzenberger (1989), we discuss the FCF hypothesis results under different model settings.

5.1 Full sample regression results

We first discuss the differences in results regarding the three alternative measures of future investment opportunities, namely, the sales ratio, Tobin's Q, and the fundamental Q. Table 3 reports the basic investment model regression results. Overall, seven models are considered. Model (1) is the benchmark model without considering future investment opportunities. The reported results are consistent with economic theory and existing literature on investment-cash flow sensitivity. Higher levels of cash flow boost investment, and a momentum effect exists (positive first order autocorrelation). The coefficients on the squared investment are all negative, reflecting the possible existence of adjustment cost (the initial model in Equation 5 assumes no adjustment cost). The results are robust and consistent across all seven specifications.

Financial difficulty or the possibility of bankruptcy reduces investment, so that the coefficient on the debt to capital ratio is significant and negative. This effect is economically weaker (model 2f) or insignificant (models 3f and 4f) when the GFC dummy is included, however, suggesting that the debt to capital ratio is more important for investment decisions during financial crises. In other words, the results suggest that the financial distress faced by the energy firms may not necessarily the biggest problem, rather it is the GFC effects. When the general investment environment becomes poor during a financial crisis, firms reduce investment.

Regarding the three proxies used as the measure of future investment opportunities, the results for Model 2 and 3 in Table 3 show both the lagged sales and Tobin's Q generate a negative impact on firm's investment, whereas the fundamental Q has a positive impact. The results for the sales ratio and Tobin's Q are counterintuitive and may be driven by a significant correlation between sales and cash flows and/or not including the crisis dummy in regressions. Indeed, the negative effect on Tobin's Q becomes marginally significant after the GFC is considered. Perhaps a better explanation for the counterintuitive results follows the evidence in the literature that the fundamental Q, as a forward looking measure, is likely to be a better measure of future investment opportunities than either the sales ratio or Tobin's Q. Given the criticisms of Tobin's Q in the literature, our empirical evidence here indicates that it can produce incorrect conclusions about FCF problems in the case of Chinese data. In the rest of the paper we therefore report the results using only the fundamental Q as a proxy for future investment opportunities.

Table 4 and 5 report the empirical results of testing the FCF hypothesis that follows the basic strategy of Lang and Litzenberger (1989). To do so, we add interaction terms consisting of cash flows and investment opportunities (i.e. CF/K*I(.)). Lang and Litzenberger (1989) simply use the value of unity for Tobin's Q as a threshold to distinguish between good or bad investment opportunities. Setting up thresholds for the fundamental Q, however, is less obvious. To check for the robustness of the findings, we use six methods (discussed below) to separate good and bad investment opportunities in Table 4 and Table 5. The results are generally consistent.

In Table 4, four threshold values are used to distinguish between good and bad investment opportunities. The first set of models (Models from 5 to 6f) use zero as the threshold. The only difference between NFQ4 and NFQ is that the former considers an investment as a poor opportunity if the firm has negative 'fundamental' Q for at least four years within the effective sample period (2005–2012), while the latter looks only at the average. We also use Tobin's Q (value of unity) as the benchmark and find that 12% of the observations are lower than unity. Thus a dummy variable is constructed, $I(FQ_{12})$, which equals zero if the fundamental Q is above the 12% threshold, or unity otherwise. Additionally, a 30% threshold is used with the same logic to construct a dummy $I(FQ_{30})$ as a poor investment opportunity indicator. The coefficients are positively significant despite the different thresholds. The message here is clear: firms with poor investment opportunities tend to overinvest. According to the FCF hypothesis, this investment generates less benefits for the shareholders but better satisfy the management incentives. Thus, the results show that energy firms in China have a clear FCF problem and tend to invest in less profitable projects.

A further robustness check reported in Table 5, which separates the fundamental Q into three evenly divided groups (FQ1, FQ2 and FQ3), further confirms our results in Table 4. The coefficients on the interaction terms (CF/K*FQ1) of the lowest investment opportunities group (smallest fundamental Q) are positive and significant, indicating that those firms with positive cash flows but poor investment opportunities tend to invest, suggesting evidence of overinvestment problem. This result remains robust even if we consider only those firms with positive cash flows (set to zero if negative). The results for all other control variables in Table 4 and 5 stay qualitatively the same as the previous baseline regression results reported in Table 3 and therefore we do not discuss them any further.

5.2 Impact of Size and Ownership on Investment

The existing literature shows that the ownership structure matters for firms' investment decisions. In China, large firms and those firms under significant state control are less likely to be subject to major financial constraints while firms with a lower level of state control are more likely to be constrained financially. Consequently, the investment decisions of the firms are expected to be sensitive to the firm size and their ownership structure. We now investigate how these factors affect the results of the FCF test.

In this section, we consider four criteria to divide the firms into several groups: size, state share of holdings, manager share of holdings, and institutional share of holdings. Table 6 reports the results of the size groups and ownership groups I (level of state share holdings). Most of the coefficients in the regression models stay the same as before. However, the FCF problem becomes more significant for the small firms but insignificant for the large firms. We have to keep in mind that the small firms in or sample on average have relatively better investment opportunities (see Table 2). But when we investigate this issue deeper, the positive coefficient on the interaction term of CF/K and FQ1 (CF/K*FQ1) reported for the small firms suggests that these firms tend to invest when facing poor investment opportunities. Larger firms, on the other hand, show no clear tendency to have overinvestment problems since only the coefficient for the interaction term of CF/K and FQ3 (good investment group) is significant.

Overall, the results suggest that large Chinese firms invest when investment opportunities are good and are less affected by financial difficulties (as indicated by the positive but insignificant debt ratio effects). Smaller firms, on the contrary, tend to overinvest even when they face poor investment opportunities and are much more concerned with the possibility of bankruptcy (as shown by the significant negative debt ratio effects). When we look at the state ownership results, the result remains the same. In the energy related firms, large firms are associated with higher state ownership, and thus they are less likely to suffer from financial constraints and less concerned with bankruptcy (‘too big to fail’).

The FCF problem is mainly due to conflict of interest between managers and shareholders. In this sense, allowing managers to hold stakes in their own firms can potentially alleviate the agency problem. Thus, we would expect to see less of an FCF problem in firms with higher manager shareholdings. This hypothesis is confirmed in Table 7 where models from 15 to 16a are employed to capture manager shareholdings. Other things being equal, low manager shareholding firms have stronger FCF problems. The coefficient of (CF/K) ⇑FQ1 for low MANHLD firms is significant and positive, whereas it is insignificant for the high MANHLD firms. It is also interesting to note that the investment model differs considerably for firms with high manager shareholdings.

The results for institutional shareholding are reported in models from 17 to 18a in Table 7. Institutional shareholders normally have more power than private shareholders. Thus we would expect that higher institutional shareholdings would be associated with better protection of shareholders' interests. However, the results show that higher institutional shareholdings tend to make the firms suffer more from the FCF problem. One explanation for this counterintuitive finding could be related to state ownership. Firms with high institutional shareholdings tend to have less state ownership (the correlation is 0.89 in our sample). According to the results of models 13 to 14a, low state-share ownership firms are more likely to have an FCF problem. In this sense, at least for the energy related firms in China, the state ownership dominates the institutional share holdings.

6. Conclusions and Policy Implications

The rising energy prices in the new century have helped energy related firms in China accumulate significant free cash flows and investment by these firms has grown dramatically both domestically and internationally (Tan, 2013). Whether this investment increases firm value to the benefit of shareholders, or just reflects the managers' interest in the 'empire building' is subject to empirical investigation and has important policy implications for regulators pursuing efficiency. This paper follows the standard finance literature to study the agency problems and tests the FCF hypothesis for energy firms in China. Our main contributions include using a better proxy, namely the fundamental Q, testing the FCF hypothesis in alternative model settings, and taking into consideration of firm characteristics, especially their ownership structure and governance factors.

Our empirical results support the FCF hypothesis in the case of Chinese energy-related firms. We find that these firms tend to overinvest even when further investment opportunities become poor. The results are robust to different specifications of thresholds and consistent with economic theory. Investment tends to have a 'momentum' effect (positive autocorrelation) and there are also adjustment costs. The 2008 crisis has a clear role in reducing firm investment, but the same holds for the debt-capital ratio. Since the latter both represent financial difficulties, it is generally consistent that firms with financial difficulties are inclined not to invest.

The size of the firms, and their degrees of state ownership and levels of managerial and institutional share holdings are also considered. The larger the firm, the less likely it will be affected by the FCF problems, which indicates that more regulatory efforts should be made and the focus should be on the relatively smaller firms. Our results also show that the state ownership does not necessarily mean less efficiency, since firms with more state ownership are less likely to suffer from the FCF problem, whereas those firms with lower state shares tend to overinvest. There are intensive regulations and rules guiding investment in the energy and resource sectors, mainly covering the state owned firms (Tan, 2013). In this sense, the results reported in this paper may indicate that there are insufficient regulatory measures for those firms with less state shareholdings.

As managerial shareholding is found to be helpful in alleviating the agency problem, one way of solving the FCF problem may be allowing managers to hold stakes in their own firms. On the other hand, contrary to our intuition, our results indicate that higher institutional shareholdings tend to increase the FCF problem. This may be due to the fact that firms with high shares of institutional holdings are often the firms with lower levels of state ownership.

Overall, like the US oil sector, our empirical evidence supports the FCF hypothesis in the energy related firms in China, and finds evidence that firm size, ownership structure, and governance are important factors for understanding the agency problem in China's energy firms. Further evidence from other countries and episodes would be interesting to see whether other emerging economies like China suffer from the FCF problems.

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Table 1. Variable definition and sample means

Variables	Full sample mean (2001-2012)	Effective sample mean (2005-2012)	Definition
I/K	0.383	0.373	Investment expenditure ratio
CF/K	0.63	0.527	Cash flow capital ratio
TQ	1.443	1.511	Market value/Asset replacement cost
FQ	0.053	0.0533	Fundamental Q
S/K	2.739	2.836	Total sales capital ratio
P/K	0.181	0.159	Operating profit capital ratio
D/K	0.867	0.876	Debt capital ratio
Size	21.97	22.25	Log of total assets at the beginning of the year
State	26	24.16	Percentage of State share holdings
INSHLD	17.66	19.83	Percentage of Institution share holdings
MANHLD	0.025	0.014	Percentage of Manager share holdings)

Note: for all the ratios, K is the beginning of the year book value of fixed assets minus depreciation. Cash flow is defined as the depreciation of fixed assets plus operating profit before tax, interest and dividends. Effective sample excludes the first four years used to estimate the Panel VAR model.

Table 2. Average values for sub-samples

Variables	Size		State Share		MANHLD		INSHLD	
	Small	Large	Low	High	Low	High	Low	High
I/K	0.32	0.428	0.423	0.323	0.443	0.302	0.336	0.412
CF/K	0.604	0.448	0.622	0.43	0.683	0.367	0.451	0.604
TQ	1.777	1.239	1.64	1.379	1.531	1.49	1.411	1.613
FQ	0.119	0.0695	0.153	0.0445	0.0275	0.154	0.0483	0.0727
S/K	3.311	2.352	2.668	3.008	3.292	2.372	2.594	3.084
P/K	0.119	0.198	0.175	0.142	0.166	0.151	0.183	0.133
D/K	0.904	0.848	1.065	0.683	0.953	0.797	0.775	0.979
Size	21.3	23.21	21.99	22.51	22.3	22.19	22.27	22.22
State	21.29	27.09	12	36.57	28.69	19.54	21.53	26.85
INSHLD	18.6	21.1	17.4	22.3	20.2	19.5	9.02	30.9
MANHLD	0.0135	0.0148	0.0258	0.0023	0.0001	0.0285	0.0198	0.0085

Table 3: The basic investment model. This table reports system-GMM estimates of the investment model (Equation 5) for the sample of 99 firms from 2005 to 2012. For all models, the dependent variable is investment ratio (I/K). CF/K stands for Cash flow ratio. Investment is equal to cash outflow for the purchase of new fixed assets and other long-term assets as shown in cash flow statement, cash flow is the sum of depreciation of fixed assets plus operating profit, K is the net value of fixed assets at the beginning of the year. Equation (5) is unfermented with the lagged investment ($(I/K)_{t-1}$), squared of lagged investment ($(I/K)_{t-1}^2$), the squared lagged debt term, $(D/K)^2$, and the natural logarithm of total assets at the beginning year (Size). Model 1 reports the results of baseline model. Model 2 to 4 control for the investment opportunities through sales ratio ($(S/K)_{t-1}$), Tobin's Q (TQ) and the 'fundamental' Q (FQ). The impacts of 2008 GFC are considered in model 2f to 4f with similar settings as model 2 to 4. GFCdum. stands for the financial crisis dummy, which equals to 1 in the year of 2008, 2009, and zero otherwise. The lags of $(I/K)_{t-1}$, $(I/K)_{t-1}^2$, $(S/K)_{t-3}$ and $(P/K)_{t-3}$ are instruments in the system GMM estimation. Sargan test is employed to verify the null hypothesis of joint validity of instruments used in system-GMM, Autocorrelation tests are also used to determine the proper number of lags taking for the instrument variables. These testing results are not reported but available upon request. Standard errors are in brackets and we use * for 10% level of significance and ** for 5% and *** for 1%.

	(1) CF	(2) SALE	(3) Tobin's Q	(4) FQ	(2f) SALE	(3f) Tobin's Q	(4f) FQ
$(I/K)_{t-1}$	1.3839***	1.6532***	1.4211***	1.4391***	1.5318***	1.3524***	1.3226***
	(0.3745)	(0.3442)	(0.3689)	(0.3768)	(0.3561)	(0.3502)	(0.3830)
$(I/K)_{t-1}^2$	-0.0658***	-0.0762***	-0.0663***	-0.0638***	-0.0761***	-0.0683***	-0.0608**
	(0.0186)	(0.0169)	(0.0182)	(0.0189)	(0.0185)	(0.0189)	(0.0242)
CF/K	1.2368***	1.2383***	1.1964***	0.9108***	1.4771***	1.4799***	1.1370***
	(0.3007)	(0.2719)	(0.3297)	(0.2651)	(0.2791)	(0.3111)	(0.2930)
$(D/K)^2$	-0.0323***	-0.0332***	-0.0295***	-0.0250***	-0.0132*	-0.0109	-0.0013
	(0.0095)	(0.0084)	(0.0105)	(0.0080)	(0.0074)	(0.0068)	(0.0118)
Size	-0.0451	-0.0649	-0.1627	-0.0588	-0.0479	-0.1063	-0.0462
	(0.0742)	(0.0906)	(0.1029)	(0.0699)	(0.0928)	(0.1061)	(0.0774)
S/K		-0.0509***			-0.0412***		
		(0.0176)			(0.0156)		
TQ			-0.3849*			-0.2574	
			(0.2205)			(0.1720)	
FQ				1.2405*			1.4897***
				(0.7056)			(0.4303)
GFC dum.					-0.9451***	-0.9772***	-1.1226***
					(0.2611)	(0.2315)	(0.2341)
Constant	0.2234	0.7045	3.2475	0.6723	0.2209	1.7361	0.2721
	(1.6902)	(2.0526)	(2.3973)	(1.5690)	(2.1046)	(2.5488)	(1.7039)
Obs.	792	792	792	792	792	792	792

Table 4: Testing for the FCF hypothesis: full sample. This table reports system-GMM estimates of the testing regressions of full sample. For all models, the dependent variable is investment ratio (I/K). CF/K stands for Cash flow ratio. We use four methods to classify good investment opportunities and bad investment opportunities. Neg. FQ 4 considers minimum four years of negative 'fundamental' Q as poor investment opportunities, Neg. FQ consider only the negative 'fundamental' Q as the representative. FQ12 and FQ 30 use 12% and 30% of the 'fundamental' Q as the cutting off points respectively. I(·) is the indicator function equals to unit if the statement in the brackets is true and zero otherwise. Each model include the 2008 GFC has a *f* suffix. The lags of $(I/K)_{t-1}$, $(I/K)^2_{t-1}$, $(S/K)_{t-1}$ and $(P/K)_{t-1}$ are used as instruments in the system GMM estimation. Sargan test is employed to verify the null hypothesis of joint validity of instruments used in system-GMM, Autocorrelation tests are also used to determine the proper number of lags taking for the instrument variables. These testing results are not reported but available upon request. Standard errors are in brackets and we use * for 10% level of significance and ** for 5% and *** for 1%.

	Neg. FQ4		Neg. FQ		FQ12		FQ30	
	(5)	(5f)	(6)	(6f)	(7)	(7f)	(8)	(8f)
$(I/K)_{t-1}$	1.0979**	1.1201***	1.2259**	1.1908***	1.2529***	1.1817***	1.2857***	1.2067***
	(0.4812)	(0.2972)	(0.4964)	(0.3371)	(0.4462)	(0.3184)	(0.4787)	(0.3317)
$(I/K)_{t-1}^2$	-0.0528**	-0.0562***	-0.0584**	-0.0585***	-0.0593***	-0.0583***	-0.0603***	-0.0590***
	(0.0220)	(0.0150)	(0.0227)	(0.0169)	(0.0206)	(0.0159)	(0.0223)	(0.0167)
CF/K	0.2154	0.2041	0.0157	0.1246	0.0498	0.1463	0.0154	0.1281
	(0.2401)	(0.1828)	(0.1949)	(0.1774)	(0.1636)	(0.1548)	(0.1913)	(0.1757)
FQ	1.4949**	1.7280***	1.9475***	2.0723***	1.8434***	1.9936***	1.9263***	2.0632***
	(0.6150)	(0.3205)	(0.3214)	(0.2427)	(0.3099)	(0.2329)	(0.3187)	(0.2469)
CF/K*I(NFQ4)	0.6613*	0.7528***						
	(0.3459)	(0.2274)						
CF/K*I(NFQ)			0.9318***	0.8152***				
			(0.2360)	(0.1938)				
CF/K*I(FQ12)					1.0017***	0.8529***		
					(0.1702)	(0.1706)		
CF/K*I(FQ30)							0.9808***	0.8263***
							(0.2022)	(0.1819)
CF/K*GFCdum		-1.0152***		-0.8243***		-0.8048***		-0.8307***
		(0.1776)		(0.2427)		(0.2386)		(0.2395)
$(D/K)^2$	-0.0076	0.0067	-0.0160	0.0011	-0.0279***	-0.0033	-0.0265***	-0.0013
	(0.0194)	(0.0117)	(0.0119)	(0.0111)	(0.0021)	(0.0085)	(0.0030)	(0.0081)
Size	-0.0706	-0.1243**	-0.0963*	-0.1318**	-0.0891*	-0.1260**	-0.1062*	-0.1338**
	(0.0507)	(0.0482)	(0.0550)	(0.0545)	(0.0506)	(0.0538)	(0.0582)	(0.0573)
Constant	1.2460	2.3916**	1.8593	2.5714**	1.7491	2.5002**	2.0553	2.6075**
	(1.1054)	(1.0217)	(1.1732)	(1.1567)	(1.0748)	(1.1334)	(1.2389)	(1.2125)
Obs.	792	792	792	792	792	792	792	792

Table 5: Testing for the FCF hypothesis: in three groups

This table reports system-GMM estimates of the testing regressions of full sample. For all models, the dependent variable is investment ratio (I/K). CF/K stands for Cash flow ratio. We classify good investment opportunities and bad investment opportunities according to the level of 'fundamental' Q into three groups. Group 1 is the lowest, which is labeled as FQ1 and group 3 has the best opportunities and labeled as FQ3. Each model include the 2008 GFC has a f suffix. The lags of $(I/K)_{t-1}$, $(I/K)^2_{t-1}$, $(S/K)_{t-1}$ and $(P/K)_{t-1}$ are used as instruments in the system GMM estimation. Sargan test is employed to verify the null hypothesis of joint validity of instruments used in system-GMM, Autocorrelation tests are also used to determine the proper number of lags taking for the instrument variables. These testing results are not reported but available upon request. Standard errors are in brackets and we use * for 10% level of significance and ** for 5% and *** for 1%.

	(9)	(9f)	(10)	(10f)
	Cash flow		Positive cash flow	
$(I/K)_{t-1}$	1.2507***	1.1761***	1.1612***	1.1106***
	(0.4621)	(0.3099)	(0.3952)	(0.2747)
$(I/K)_{t-1}^2$	-0.0590***	-0.0580***	-0.0551***	-0.0551***
	(0.0215)	(0.0157)	(0.0186)	(0.0141)
FQ	1.7784***	1.8413***	1.8019***	1.8698***
	(0.3117)	(0.3152)	(0.3046)	(0.2879)
CF/K*FQ1	1.0263***	0.9958***	1.0453***	1.0056***
	(0.0911)	(0.0886)	(0.0918)	(0.0847)
CF/K*FQ2	-0.1034	-0.0173	-0.0766	-0.0172
	(0.2153)	(0.0918)	(0.1958)	(0.1004)
CF/K*FQ3	0.1252	0.282	0.1292	0.2717
	(0.2483)	(0.2158)	(0.2480)	(0.2159)
CF/K*GFCdum		-0.8568***		-0.8451***
		(0.2364)		(0.2306)
$(D/K)^2$	-0.0272***	-0.0016	-0.0276***	-0.0022
	(0.0034)	(0.0078)	(0.0036)	(0.0074)
Size	-0.1031	-0.1406**	-0.0874	-0.1336**
	(0.0624)	(0.0574)	(0.0591)	(0.0524)
Constant	1.9822	2.7546**	1.6596	2.6133**
	(1.3421)	(1.2074)	(1.2811)	(1.1122)
Obs.	792.00	792.00	792.00	792.00

Table 6: Testing for the FCF hypothesis: Group I

This table reports system-GMM estimates of the testing regressions of sub-group set I. For all models, the dependent variable is investment ratio (I/K). CF/K stands for Cash flow ratio. We classify good investment opportunities and bad investment opportunities according to the level of 'fundamental' Q into three groups. Group 1 is the lowest, which is labeled as FQ1 and group 3 has the best opportunities and labeled as FQ3. The sub-samples are separated according to size (model 11-12a) and state ownership (model 13-14a). The lags of $(I/K)_{t-1}$, $(I/K)^2_{t-1}$, $(S/K)_{t-1}$ and $(P/K)_{t-1}$ are used as instruments in the system GMM estimation. Sargan test is employed to verify the null hypothesis of joint validity of instruments used in system-GMM, Autocorrelation tests are also used to determine the proper number of lags taking for the instrument variables. These testing results are not reported but available upon request. Standard errors are in brackets and we use * for 10% level of significance and ** for 5% and *** for 1%.

	Sub-sample (size groups)				Sub-sample (ownership groups)			
	Large size		Small size		High state share		Low state share	
	(11)	(11a)	(12)	(12a)	(13)	(13a)	(14)	(14a)
$(I/K)_{t-1}$	0.5207***	0.5566***	0.8647*	0.8312**	0.1462	0.1493	1.5404***	1.5176***
	(0.1872)	(0.1942)	(0.4705)	(0.3639)	(0.1850)	(0.1823)	(0.2576)	(0.2679)
$(I/K)_{t-1}^2$	-0.0305***	-0.0331***	-0.0417**	-0.0435***	-0.0077	-0.0133	-0.0648***	-0.0650***
	(0.0104)	(0.0114)	(0.0189)	(0.0150)	(0.0189)	(0.0214)	(0.0164)	(0.0162)
CF/K	0.4114**		0.7478***		0.2269			0.8160***
	(0.1724)		(0.1980)		(0.1929)			(0.2245)
FQ	0.8185*	0.7590	0.4799	1.0452***	1.3897**	1.1069**	1.7923***	1.6387***
	(0.4738)	(0.4743)	(0.3835)	(0.3448)	(0.5843)	(0.4947)	(0.5503)	(0.5599)
CF/K*FQ1		0.3392		1.1732***		-0.1814		0.9149***
		(0.2888)		(0.1149)		(0.1505)		(0.2382)
CF/K*FQ2		0.2886		-0.1444		0.6805		0.2450
		(0.4751)		(0.6139)		(0.5607)		(0.5283)
CF/K*FQ3		0.4440***		-0.1022		0.3652**		0.8384**
		(0.1381)		(0.1248)		(0.1620)		(0.3209)
$(D/K)^2$	0.0056	0.0046	-0.0184***	-0.0326***	0.0211	0.038	-0.0246***	-0.0268***
	(0.0106)	(0.0098)	(0.0067)	(0.0033)	(0.0461)	(0.0276)	(0.0077)	(0.0078)
Size	-0.0853	-0.1069	-0.3289*	-0.2839	-0.0558	-0.0345	0.107	0.1231
	(0.0696)	(0.0906)	(0.1814)	(0.1701)	(0.0507)	(0.0349)	(0.1105)	(0.1125)
Constant	1.8504	2.3366	6.4758*	5.9026*	1.2372	0.6407	-3.1505	-3.376
	(1.5720)	(2.0282)	(3.7457)	(3.5094)	(1.0412)	(0.8662)	(2.4622)	(2.5063)
Obs.	392	392	400	400	392	392	400	400

Table 7: Testing for the FCF hypothesis: Group II

This table reports system-GMM estimates of the testing regressions of sub-group set II. For all models, the dependent variable is investment ratio (I/K). CF/K stands for Cash flnv ratio. We classify good investment opportunities and bad investment opportunities according to the level of 'fundamental' Q into three groups. Group 1 is the lowest, which is labeled as FQ1 and group 3 has the best opportunities and labeled as FQ3. The sub-samples are separated according to manager share holding (MANHLD, model 15-16a) and institution share holdings (INSHLD, model 17-18a). The lags of $(I/K)_{t-1}$, $(I/K)^2_{t-1}$, $(S/K)_{t-1}$ and $(P/K)_{t-1}$ are used as instruments in the system GMM estimation. Sargan test is employed to verify the null hypothesis of joint validity of instruments used in system-GMM, Autocorrelation tests are also used to determine the proper number of lags taking for the instrument variables. These testing results are not reported but available upon request. Standard errors are in brackets and we use * for 10% level of significance and ** for 5% and *** for 1%.

	Sub-sample (ownership groups II)				Sub-sample (ownership groups III)			
	High MANHLD		Low MANHLD		High INSHLD		Low INSHLD	
	(15)	(15a)	(16)	(16a)	(17)	(17a)	(18)	(18a)
$(I/K)_{t-1}$	0.0477	0.0430	1.5002***	1.5659***	1.0916*	1.1288***	0.8787**	0.6641*
	(0.1896)	(0.1876)	(0.3928)	(0.3350)	(0.5681)	(0.4136)	(0.4059)	(0.3888)
$(I/K)_{t-1}^2$	0.0197	0.0206	-0.0670***	-0.0706***	-0.0472*	-0.0536***	-0.0446*	-0.0341
	(0.0352)	(0.0370)	(0.0183)	(0.0159)	(0.0259)	(0.0183)	(0.0253)	(0.0245)
CF/K	0.3703*		0.7240***		0.5275***		0.1593	
	(0.1984)		(0.1828)		(0.1573)		(0.1392)	
FQ	0.7222**	0.7627*	1.5250**	1.6499***	1.8364***	2.0603***	1.7456***	1.0632***
	-0.3118	-0.4367	-0.5815	-0.4779	-0.5911	-0.4768	-0.2526	-0.2946
CF/K*FQ1		0.4563		0.7810***		0.9567***		0.0317
		(0.6347)		(0.2678)		(0.1139)		(0.0710)
CF/K*FQ2		0.4485		0.7233		0.0316		0.2946
		(0.4901)		(0.8683)		(0.8353)		(0.3295)
CF/K*FQ3		0.3494		0.6188		-0.6547		0.5541**
		(0.2563)		(0.4160)		(0.5606)		(0.2353)
$(D/K)^2$	0.0042	0.0031	-0.0187***	-0.0207**	-0.0138**	-0.0252***	0.0068	0.0126
	(0.0276)	(0.0325)	(0.0056)	(0.0078)	(0.0055)	(0.0049)	(0.0183)	(0.0201)
Size	-0.0325	-0.0298	-0.0222	-0.0195	-0.0915	-0.0062	-0.1003	-0.0607
	(0.0647)	(0.0641)	(0.0734)	(0.0676)	(0.0742)	(0.0428)	(0.0726)	(0.0734)
Constant	0.62	0.546	-0.1326	-0.1905	1.621	-0.0115	2.0606	1.1841
	(1.3877)	(1.3869)	(1.6990)	(1.6007)	(1.5211)	(1.0146)	(1.5088)	(1.5062)
Obs.	392	392	400	400	392	392	400	400

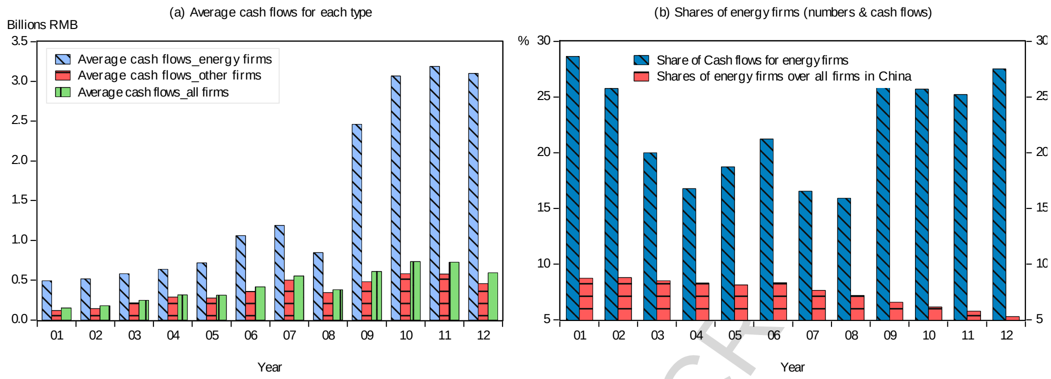

Figure 1: Cash flows in energy firms and others (Source: authors' own calculation from RESSET database. The unit in panel (a) is billions RMB and panel (b) is percentage.)

Highlights

- We test whether the Chinese energy firms tend to misallocate resources due to growing free cash flows.
- A dynamic panel model for the period 2001-2012 for the Chinese energy-related public listed firms is employed.
- We find evidence supporting the free cash flow hypothesis, suggesting over-investment problems in the Chinese energy sector.
- Firm size and corporate governance structure are important determinants of the Chinese energy firms' investment decisions.